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1939-1940

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HAWAIIAN ACADEMY OF SCIENCE

The Hawaiian Academy of Science was organized July 23, 1925, for "the promotion of research and the diffusion of knowledge."

The sessions of the Fifteenth Annual Meeting were held in Social Science Hall, University of Hawaii, November 16 and 17, 1939, and April 11 and 12, 1940, ending with a banquet at the Pacific Club on April 13.

OFFICERS

1939-1940

President, Harry L. Arnold
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PROGRAM OF THE FIFTEENTH ANNUAL MEETING

THURSDAY, NOVEMBER 16, 1939, 7:30 P. M.

Preliminary announcements.

Presentation of papers:

Winston W. Jones: The influence of relative humidity on the thermal death point of the papaya.

C. P. Sideris, H. Y. Young, and B. H. Krauss: Conditions favoring the accumulation of ascorbic acid in pineapple plant tissues.

Joseph E. Alicata: Life history and control of the liver fluke of cattle in Hawaii.

Martha Potgieter: Utilization of the calcium and phosphorus of taro.

Peter H. Buck: Anthropology and religion.

FRIDAY, NOVEMBER 17, 1939, 7:30 P. M.

Martin E. Nelson and Stanley S. Ballard: A spectrographic method for the determination of vitamin A in oils.

W. H. Hammond, W. Y. Young, and F. Fong: Metallurgical analysis of nickel in steel by spectrograph.

Horace Winchell: Mineralogy: Augite crystals from the Koko region, from Puu Pa, and from Haleakala.

Thomas A. Jaggar: Gases of primary volcanism.

Richard H. P. Sia: Epidemiological studies of scarlet fever and diphtheria in North China.

THURSDAY, APRIL 11, 1940, 7:30 P. M.

Harold S. Palmer: Altitude and azimuth chart for photography in Hawaii.

O. N. Allen and Ethel K. Allen: False nodulation on certain leguminous species.

Edward Y. Hosaka: A revision of the Hawaiian species of Myrsine (Suttonia, Rapanea). (By title only.)

H. A. Wadsworth: The cost of sugar as related to the irrigation interval.

Hugh H. Waesche: Tilting of the ground at Kilauea.

Stephen B. Jones: Lags and ranges of temperature in Hawaii.

FRIDAY, APRIL 12, 1940, 7:30 P. M.

J. Ripperton and E. Y. Hosaka: The ecological approach as a basis for agricultural development in Hawaii.

John W. Coulter: Land utilization in the Territory of Hawaii, 1940.

H. David Michener: Control of dormancy in seed potatoes.

George C. Munro: Decrease of Hawaiian passerine birds.

Harold T. Stearns: The occurrence of ground water in the Hawaiian islands.

SATURDAY, APRIL 13, 1940, 6:30 P. M.

Pacific Club banquet.

Constitutional order of business.

Installation of new officers.

Election of members.

Address by Dr. M. F. Haralson: Syphilis from the public health standpoint.

Adjournment.

ABSTRACTS OF PAPERS

SYPHILIS FROM THE PUBLIC HEALTH STANDPOINT

By

M. F. HARALSON

(Special Address)

Syphilis was probably introduced into Europe by Columbus' sailors. There it spread rapidly, but for 400 years mercury was the only method of treatment used, and little else was learned of its cure. Not until the twentieth century were the organism which causes the disease, the Wassermann test, and treatment by special arsenical compounds discovered.

However, the application of this knowledge and widespread interest in the prevention and control of syphilis has been slow, probably due to the fact that two decades ago the American public knew nothing about the disease.

As early as 1876, Dr. J. Marion Sims, then President of the American Medical Association, recognized the need of disseminating information to the laity as well as the medical profession, and urged that syphilis be dealt with in the same manner as other communicable diseases; but it was not until 1912, with the organization of the American Social Hygiene Association, that much was done about it openly. The seriousness of the problem was revealed during the World War, resulting in an appropriation by Congress in 1918, but with the curtailment of federal subsidy after the war, much of the work lapsed.

The Social Security law enacted in 1935 granted funds for research and assistance to the states. Further expansion of the venereal disease control program resulted from passage of the LaFollette-Bulwinkle Bill, authorizing appropriations increasing each year over a three-year period, up to the amount of $7,000,000 for the fiscal year ending June 30, 1941.

The necessary points in a properly organized control program are:

1. Supervision by a full-time, well-trained physician, and assistance of competent personnel.
2. Free diagnostic services.
3. Reporting of all cases to the health department.
4. Free treatment for indigents.
5. Location and treatment of sources and contacts of infection.
6. Education and cooperation of the public and medical profession.

THE INFLUENCE OF RELATIVE HUMIDITY ON THE THERMAL DEATH POINT OF PAPAYA AS INDICATED BY RESPIRATORY CURVES

By

WINSTON W. JONES

The temperature tolerance of most plant material is relatively narrow. Little metabolic activity occurs below 0 degrees C., and the thermal death point lies between 45 and 55 degrees C. for most plants. Three factors which greatly influence the thermal death point are (1) the water content of the plant material, (2) the relative humidity of the surrounding air, and (3) the length of time the high temperature is maintained. The present paper deals with relative humidity as it influences papaya fruits subjected to the vapor-heat treatment. The vapor-heat treatment, as prescribed by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture consists in holding the temperature of the fruits at 43.3 degrees (110 degrees F.) for 8 hours during which time the air must be fully saturated with water vapor. The purpose of this treatment is to eliminate the Mediterranean fruit fly and melon fly so that Hawaiian fruits and vegetables may be safely shipped to the mainland United States.

From the experiments reported it is shown that papaya fruits are severely injured when subjected to a temperature of 43.3 degrees C. under saturated conditions for a period of 16 hours or longer. It is further shown that with a relative humidity of 60 percent, other conditions remaining the same, visible injury does not occur. The rate of carbon dioxide production reaches a higher peak after a longer period of treatment and then falls more rapidly under a condition of saturation than under a condition of 60 percent relative humidity. The factor or factors that cause injury under the saturated condition and not under the condition of lower humidity are not clear. It is thought that the lower water content of the fruit treated at low humidity, brought about by the increased rate of transpiration, is the important factor in preventing injury.

(This report has been published in full in Proc. Am. Soc. Hort. Sci. **37**: 119-124, 1939.)

CONDITIONS FAVORING THE ACCUMULATION OF ASCORBIC ACID IN PINEAPPLE PLANT TISSUES

By

C. P. SIDERIS, H. Y. YOUNG, AND B. H. KRAUSS

Studies conducted on the distribution of ascorbic acid, as determined by sodium 2, 6 dichlorobenzenone indophenol, in different sections of the stem and leaves of pineapple plants have demonstrated its presence only in the chlorophyllous sections of the leaves. The non-chlorophyllous sections contain either mere traces of ascorbic acid or none. By comparing the amounts of ascorbic acid in comparable sections of the old, mature, active, and young groups of leaves, we find that the highly differentiated and physiologically very active tissues of the leaves contain more ascorbic acid than either the less differentiated meristematic or the less active and old tissues.

The data indicate that ascorbic acid reaches its peak only in the fully expanded and mature leaves. In the old leaves, where protoplasmic vigor and activity have been considerably reduced, the amounts of ascorbic acid are appreciably lower. The titratable acidity values of the leaves due, possibly, to such organic acids as malic or citric, are greater in the highly differentiated tissues of the young than of the more advanced groups of leaves.

Pineapple fruits have considerably higher values of ascorbic acid during the flowering than the subsequent periods of growth. After the flowering period, the values drop quite appreciably but after their initial drop they remain fairly constant during the growth and maturation periods of the fruits. During the ripening period ascorbic acid values become slightly lower and with overripe fruits they are still lower.

The data suggest that ascorbic acid is produced in highly differentiated tissues possessing very great protoplasmic functional activity. In specialized tissues lacking such activity, such as the water conducting vessels or storage cells, ascorbic acid values are nil.

The data show clearly that tissues from very young fruits, although lacking complete development, contain more ascorbic acid than tissues from the meristematic regions of either the leaves or the stem. Fruit tissues have highly specialized functions very early in their development, whereas very young leaf or stem tissues lack this functional specialization.

(This complete report will be published in Jour. Biol. Chem.)

LIFE HISTORY AND CONTROL OF THE LIVER FLUKE OF CATTLE IN HAWAII

By

JOSEPH E. ALICATA

The life history of *Fasciola gigantica* resembles that of other fascioloid flukes. Eggs eliminated with the feces of cattle, in the presence of water, develop into miracidia and in about 2 weeks hatch. The miracidium bores into fresh-water snails (*Fossaria*) and during a period of 6 weeks develops into a series of stages known as sporocyst, redia, daughter redia, and cercaria. Mature cercariae leave the body of the snail and encyst on surrounding vegetation. Whenever infected vegetation is eaten by cattle, the flukes eventually reach the liver and in about 3 months reach maturity.

Fluke control depends largely on three factors, namely:

1. Treatment of infected animals: with (a) "distol", (b) kamala, or (c) hexachloroethane. The last two are still under experimentation.
2. Prevention of animals from becoming infected: by (a) fencing off swampy areas, and (b) feeding grass cut from non-swampy districts.
3. Destruction of fresh-water snails: by use of (a) drainage, (b) copper sulphate, (c) biological control.

Method 3 has received comparatively little attention. After a careful study of known predators on aquatic snails, the writer suggested the possible use of aquatic fireflies of the genus *Luciola,* common in the Orient. These insects are reported as being absolutely harmless and, according to personal communications with Y. K. Okada and Hachiro Yuasa, Japanese entomologists, the larvae are exclusively carnivorous and consume a large number of snails. The writer offered this suggestion to D. T. Fullaway, Territorial entomologist of the Board of Agriculture and Forestry, and, as a result, species of fireflies have been imported by him from Japan and the Philippines. Observations are now in progress to determine the possible establishment of these insects locally and to determine to what extent they may control the fresh-water snail carriers of liver flukes.

THE UTILIZATION OF THE CALCIUM AND PHOSPHORUS OF TARO

By

MARTHA POTGIETER

Digestion experiments with young rats and with adult women, on diets high in taro, show that the calcium and phosphorus of taro are readily digested and absorbed by the animal digestive system.

Compared, in rats, with the availability of the calcium and phosphorus of soluble inorganic salts (which are known to be readily digested and absorbed), the availability of the calcium and phosphorus in taro was found to be 80 percent.

The two human subjects were placed on a diet high in poi, in which poi furnished 80 percent of the calcium present, maintained calcium equilibrium on a daily calcium intake equal to the average daily minimum requirement of 6.4 mg. per kilogram of body weight. This shows that the calcium of poi is readily utilized by the human digestive tract and that poi, though not so rich in calcium as milk, is capable of supplying an adult's daily requirement for this mineral in a form which is readily utilized.

On the basis of these results the increased production and use of taro are being strongly urged in Hawaii today.

(This report will be published in full in Am. Dietetics Assoc. Jour.)

ANTHROPOLOGY AND RELIGION

By

PETER H. BUCK

Polynesian religion may be dealt with in three stages. Firstly, the creation of gods by man through the deification of ancestors. Secondly, the creation of man by the gods when an organized priesthood in central Polynesia institutionalized a pattern of theology. Thirdly, the death of the gods when the Polynesians accepted Christianity and renounced their own gods. Polynesian religion was so interwoven with the social structure of the people that the renouncement of the gods led to the abandonment of many customs and observances that formed an integral part of Polynesian culture. Hence, the death of the gods led to the decay of the culture with which they were associated. The Christian religion is an integral part of western civilization and its abandonment by European nations may lead to the wreck of western civilization.

A SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF VITAMIN A IN OILS

By

MARTIN E. NELSON AND STANLEY S. BALLARD

A modified spectrographic method has been developed for the determination of vitamin A in oils by the measurement of the absorption of light at 3,280 angströms. The extinction coefficient, $E = \log (I_o/I)$, for a 1 percent solution (in ethyl alcohol) in a 1 cm. cell, is used as a measure of the vitamin A content of that solution. In practice, I_o and I are the intensities of the light transmitted by 1 cm. of pure solvent and of solution, respectively. These intensities are evaluated from the measured densities of the photographic plate at the maximum of the vitamin A absorption band. The densities may be obtained from the characteristic curve of the photographic plate, in which case the plate must be calibrated. Or, since the blackening or density (D) of the exposed plate is linearly proportional to log I, within limits, the intensity ratio can be found directly from the difference (D_o—D), where D_o and D are densities of the solvent and solution strips respectively. Using these two methods of determination, E values were calculated for the non-saponifiable fraction of the Reference Cod Liver Oil of the United States Pharmacopoeia, which is standardized to contain 3,000 International Units of vitamin A per gram. The mean values obtained were respectively 1.441 ± 0.019 (21 determinations), and 1.434 ± 0.020 (19 determinations), with standard deviations of 0.084 ± 0.013 and 0.087 ± 0.014. These means agree well with the value 1.44 reported by E. M. Hume (Nature **143**:22, 1939).

Three commercial cod liver oils were assayed by comparison with the standard United States Pharmacopoeia Reference Oil. The mean potencies obtained were 6,170, 2,600, and 1,700 International Units per gram. These oils were advertised to contain not less than 6,000, 2,000 and 1,800 International Units per gram, respectively. Absorption spectrograms were taken of extracts of the hepatopancreas of *opihi,* the Hawaiian limpet. They failed to show the vitamin A band, but showed the characteristic absorption bands of β—carotene.

METALLURGICAL ANALYSIS OF NICKEL IN STEEL BY SPECTROGRAPH

By

W. H. HAMMOND, W. Y. YOUNG, AND F. FONG

We have been working on the details of a quantitative determination of nickel in steel by arc spectroscopy, using a Hasler and Lindhurst Grating Spectroscope. No particular claim is made to originality of the method used. We worked out the details, however, so that alloy steels could be picked out from plain carbon steels with a saving in time over ordinary wet methods. The calibration curve, which we set up, was based on Bureau of Standards analyzed steels, and determined nickel in the range 0.1-2.5 percent with an accuracy, at worst, of about 10 percent. From the same spectra in which we determined nickel quantitatively, we could make a qualitative analysis for chromium, molybdenum, vanadium, and others, with an approximation of the amounts present sufficiently close to grade the steels. We hope to increase the accuracy and reproductibility of our results by substituting spark for arc technique, using apparatus designed by S. S Ballard of the University of Hawaii.

MINERALOGY: AUGITE CRYSTALS FROM THE KOKO REGION, FROM PUU PA AND FROM HALEAKALA

By

HORACE WINCHELL

Augite crystal lapilli are well known from various parts of the world, including the summit of Haleakala, Maui, Hawaiian islands. A study of crystals from several localities in the Territory seems to indicate that they should be classified in two major types, one of which comprises two subtypes.

The first major type is that of Haleakala. Its composition as determined analytically by Washington and Merwin (Am. Jour. Sci., V, 3:117-122, 1922) indicates that it contains about 70 percent diopside, 15 percent hedenbergite, 5 percent acmite, and nearly 9 percent alumina and ferric oxide. This type of material is widespread in the basaltic lavas of Hawaii, and isolated crystals of it sometimes occur as lapilli in tuff (and cinder) formations, and sometimes as phenocrysts weathered out of lava flows. Such augite crystals occur at Red Hill on the rim of Haleakala Crater, and at no less than four localities in the crater, as well as at Puu Olai, on the southwest shore of the mountain. These

crystals are optically very similar to most pyroxene phenocrysts encountered in all other parts of the Hawaiian islands, associated with basaltic or near-basaltic lavas.

In addition to the Haleakala type, there is a subtype which has similar optical properties and therefore similar composition, but which displays the zoning phenomenon known as "hourglass structure." This subtype occurs as crystal lapilli in the vicinity of Koko Crater, Oahu, having weathered out of a reddish tuff bed that caps several hills in that area. These crystals with hourglass structure appear to be confined to the lavas and pyroclastics of the Honolulu series of southeastern Oahu, occurring as phenocrysts in several of the nepheline- and melilite-bearing lavas of this group as well as in more normal basalts at Koko Crater and vicinity.

The second major type of pyroxene crystal lapilli in the Territory occurs at Puu Pa, near Waimea, Hawaii, and on the Waianae-Makaha ridge in the Waianae Mountains, Oahu. Optical properties show that this material is composed mainly of diopside, with probably less than 12 percent of all other pyroxene constituents. The extinction angle of the diopsidic material is 37 degrees as compared with 45 to 51 degrees for the augitic, and the birefringence is 0.030 instead of 0.024 to 0.025. The optic axial angle is slightly smaller. Little can be said of the associations of the diopsidic crystals. Mauna Kea and the Waianae Mountains appear to be capped by considerable thicknesses of lavas containing andesine or anemousite, but Haleakala also has a capping formation of this type. It is hoped that future studies will determine the paragenetic relations of these three kinds of pyroxene in Hawaii.

GASES OF PRIMARY VOLCANISM

By

THOMAS A. JAGGAR

By arranging analyses of gaseous constituents of Hawaiian active lava in the order of each gas, guided by progress from poor to good collections, it was found that increasing amounts of H_2O, SO_3, and Cl_2 moved from good to poor. Of those that went from poor to good CO_2, SO_2, and N_2 were the leaders, and in much smaller volume H_2, CO, and S_2. Argon is in excess of its air ratio in good collections.

Conclusions were tested by curves of analyses in sequence following respectively the order of hydrogen, carbon dioxide and the inverse of water-vapor. These three constituents vary together, and in the poor collections the volcanic

gases start from zero values. Summarized in a single diagram the curve shows water-vapor vanishing in excellent collections along with chlorine and sulphur trioxide, while the volcanic gases and the argon group increase to a mixture making perfect normal summation without water-vapor.

Comparing the proportions of the inflammables and the oxide gases in the interpretation of the several curves, it is obvious that the principal chemical process in volcanism is the water-gas reactions $H_2 + CO_2$, and secondary ones are exhaustion of atmospheric oxygen from air with inflammables to yield excessive nitrogen, and the reaction of SO_2 with hydrogen.

The fact that vacuum heating of plutonic rocks yields little nitrogen and sulphur, and increased hydrogen, led to comparison of volcanic gas collections of Hawaii, Iceland, Martinique, and Santorin. Analyses computed water-free show hydrogen increasing to 77 percent, and this agrees with vacuum-heating of granite. Carbon dioxide and hydrogen are the dominant gases of primary volcanism, and their reaction is non-explosive. Sulphur, owing to low volatility, is a crateral concentrate.

Curves are studied of 26 analyses of 10 gases from vacuum tubes collected 1917-1919 at flaming vents of molten lava. Absence of steam, except as non-explosive reaction product of effervescence, from solution of hydrogen and carbonic acid in magma, is a new conception. Steam-blast eruption becomes a secondary ground-water geyser effect of lava lowering.

EPIDEMIOLOGICAL STUDIES OF SCARLET FEVER AND DIPHTHERIA IN NORTH CHINA

By

RICHARD H. P. SIA

In North China, scarlet fever has been a very serious and dreaded disease. The mortality rate from this infection has been high, varying from 15 to 30 percent. Deaths were chiefly due to septic complications—evidences of the highly invasive nature of the scarlatinal streptococci. The introduction of scarlatinal antitoxin for the treatment of scarlet fever has helped in controlling the toxemic phase of the disease but has not been effective in checking the spread of the local streptococcal infection. Recently, sulfanilamide has been found to be highly effective in combating these septic processes.

In connection with the study on the epidemiology of scarlet fever, the hemolytic streptococci isolated from the nose and throat of scarlet fever patients and their contacts were serologically typed according to the method

recently introduced by Griffith. In carrying out this work, many technical difficulties were encountered. We were successful in overcoming most of these difficulties. As a rule, several cultures were made from each individual case at various intervals, and almost without exception, the various cultures of streptococci from the same individual fell into the same serological type.

This study shows that scarlet fever is caused by multiple types of hemolytic streptococci; that the same type of organism is as a rule found in a family where several cases occur together, and, that as high as 82.5 percent of contacts harbor the same types of organisms as those from patients. This latter finding frequently enables one to trace the source and spread of the infection. That scarlatinal infection may manifest itself in various clinical forms is also demonstrated.

After the results were obtained through the serological typing of scarlatinal streptococci, a similar study was carried out with organisms isolated from patients suffering from diphtheria and their contacts. In studying 95 strains of virulent *C. diphtheriae* obtained from active cases of diphtheria, the organisms were found to fall into 10 serological types. The result of this study again shows that whenever two or more cases of diphtheria occurred in the same family and at about the same time, the organisms invariably fell into the same type, indicating that either one infected the other or that each contracted the infection from the same source. In some instances, the sources of infection have actually been traced to carriers harboring the same serological type of *C. diphtheriae* as those from patients.

ALTITUDE AND AZIMUTH CHART FOR PHOTOGRAPHY IN HAWAII

By

HAROLD S. PALMER

Many photographs are best taken with the sunlight from a particular direction. The chart shows the altitude, or angular height, of the sun above the horizon, and its azimuth, or degrees east or west of south, for any hour of any date. Dates from the winter to the summer solstice are given at the top and dates for the rest of the year at the bottom of the chart. Morning hours are on the left and afternoon hours on the right. Vertical date lines and horizontal hour lines form a rectangular network on which two sets of curves are superposed.

The desired altitude and azimuth are first determined. The intersection of the corresponding curves is next found. Going horizontally from this point

we find the hour of the day, remembering that the sun is east of south in the morning, and west in the afternoon. As there are two dates in the year when the sun follows the same path, we have our choice of two dates which are found by going vertically up or down from the intersection.

The time shown is local apparent time. Its difference from standard time (involving the equation of time and differences in longitude) introduce maximum errors of about 5 degrees in altitude and 8 degrees in azimuth, except around noon in midsummer when errors of azimuth become excessive. Therefore, azimuths are not plotted for these times. This omission is not serious as the sun is then nearly overhead. Differences in latitude within the Territory of Hawaii introduce maximum errors of about 2 degrees in both altitude and azimuth.

The data on which the chart is based are given in U. S. Hydrographic Office Publication 201, "Simultaneous Altitudes and Azimuths of Celestial Bodies."

FALSE NODULATION ON CERTAIN LEGUMINOUS SPECIES

By

O. N. Allen and Ethel K. Allen

It is well known that ordinarily when a leguminous plant is infected with appropriate rhizobia typical nodules are formed on the root systems and as a result of the symbiosis the plant benefits from the fixation of atmospheric nitrogen. Although normal nodules show considerable variation in size and shape depending upon the plant species as well as the rhizobium concerned, they may be characterized as hypertrophied plant tissue having (a) a periphery of loosely packed cortical cells, the majority of which are devoid of prominent cellular contents; (b) an innermost region, or the bacteroid area, consisting of plant cells packed with the nitrogen-fixing bacteria; and (c) a conspicuously branched vascular system which connects the nodule with the vascular system of the root.

The present study concerns an atypical type of swelling found frequently at the bases of secondary roots and in the root axils of soybean, peanut, and sesbania plants grown under controlled greenhouse conditions. These bulbous swellings were found to encircle some roots forming a collar at the base. The name "false nodules" has been given to these structures inasmuch as they may readily be mistaken for true nodules if only casually examined. Because of their occurrence on the roots of control plants and plants treated with incom-

patible inocula, isolations of rhizobia were attempted for the purpose of confirming them as nodules. The failure to demonstrate rhizobia by a variety of cultural methods prompted a histological study in order to ascertain their anatomical nature. The following conclusions are warranted at this time:

1. The outgrowths termed false nodules are merely hypertrophied cortical parenchyma completely lacking in a differentiation of tissues.

2. All sections of false nodules fixed in modified Flemming's solution and stained with Heidenhain's iron-alum haematoxylin, using alkaline crystal violet as the counterstain followed by an iodine mordant, showed heavy deposits of starch grains in the innermost cells. This technique, believed to be new to stain technology, is hereby recommended in the examination of true nodule tissues because of its ability to demonstrate bacteria, infection threads, nuclear structures, and starch grains with equal clarity in the same section.

3. None of the false nodules examined showed evidence of infection, nor were bacteria demonstrated during any stage of their development.

From a practical standpoint false nodules demand a certain amount of attention since there is a possibility of their being interpreted as true nodules by agriculturists. Similarly might false nodules be the explanation of many irregularities current in cross-inoculation data. Accordingly, it is suggested that in doubtful cases such formations should be sliced with a knife; whereupon, to the unaided eye true nodules will show an inner zone (bacteroid area) of pink or grayish color in contrast to false nodules which will be totally lacking in differentiation.

A REVISION OF THE HAWAIIAN SPECIES OF MYRSINE (SUTTONIA, RAPANEA)

By

EDWARD Y. HOSAKA

The genus *Myrsine* is found in the tropical and subtropical regions with the highest development in the Malaysian area. The relationship of the species in the genus indicates a Malaysian affinity of the Hawaiian species (*kolea*).

The species in Hawaii are either trees or shrubs with variable leaves. The flowers are clustered on raised bracteate gemmules in the axils of the leaves or on naked stems below the leaves. The fruits are less than 0.25 inch across and depressed-globose or round; their color at maturity is dark purple.

The genus in Hawaii is represented by two groups of plants; those that have more or less distinct and definite characters, and those that have fluctuat-

ing characters. The least variable plants are found on Kauai, the most variable ones on Hawaii.

The variation in the habit of the species in relation to environment is rather striking. The large tree species are found in the lower forests where the rainfall is moderate and the sunshine abundant. With an increase in elevation above certain levels, especially in the rain forest, the species become smaller until under bog conditions they are dwarfed and usually have small leaves.

Willis' age and area theory, when applied to this group of plants, seems to work nicely. Some of the species have a wide distribution while others are confined to a small area. The greatest development of the genus in Hawaii is at present in the high, wet mountains of Kauai. Kauai is considered an old island, hence the fauna and flora are more highly developed than those of the other islands. There are 16 species and 1 variety found on Kauai, and of this number 13 are peculiar to the island. Oahu has the next largest total number, 8 species and 3 varieties. Molokai has 6, Maui 5, and Lanai 4 species. Hawaii, the largest but the youngest island, has only 3 species and all of them are common on the other islands.

(This report has been published in full by Bernice P. Bishop Museum, Occ. Papers **16** (2): 25-76, 1940.)

THE COST OF SUGAR AS RELATED TO THE IRRIGATION INTERVAL

By

H. A. WADSWORTH

The water requirements of the sugar-cane plant have long been the subject of experimentation. Recent work under the authority of the Experiment Station of the Hawaiian Sugar Planters' Association demonstrated that maximum yields of cane, and presumably of sugar, would be produced if the plants were continuously kept in full vegetative vigor, insofar as this condition might be affected by irrigation manipulation. This end can be gained by irrigating at such intervals that the soil moisture never falls below the permanent wilting percentage.

Another aspect is presented if the aim of irrigating is to produce a ton of sugar for the smallest cash outlay for water and for the labor of applying that water. An experiment to test the economic values associated with irrigation has recently been completed at the Waialua Agricultural Company.

Three irrigation practices were established in a well replicated experiment.

One of these involved irrigating at such intervals that the soil moisture never fell below the permanent wilting percentage. In another, four days of soil moisture deficiency were suffered by the plants after the exhaustion of readily available soil moisture from each irrigation. In the third treatment, the period of soil moisture deficiency was increased to eight days. For convenience, the variables are called the "zero idle day," "four idle day" and "eight idle day" treatments. Results are summarized in the following table:

TREATMENT	YIELD PER ACRE		IRRIGATION COSTS PER TON OF SUGAR		NUMBER OF IRRIGATIONS
	CANE (TONS)	SUGAR (TONS)	WATER M. G.	LABOR MAN DAYS	
0—idle days	75.6±0.71	9.2±0.23	0.859	1.786	41.1
4—idle days	72.8±1.53	9.1±0.21	0.579	1.217	27.2
8—idle days	69.0±0.91	8.8±0.11	0.517	1.025	22.6

It is apparent that the manipulation of the irrigation schedule was effective in modifying the yield of cane; there are no significant differences between the yields of sugar.

Although the availability of nitrogen and the light intensities involved undoubtedly contribute to the results obtained it is thought that these factors were equally effective on all plots. The interrelation between the effects of soil moisture, available nitrogen, and environment factors in the production of sugar at the lowest possible cost, deserves further study.

The following table gives comparative cost data for a plantation operating under two different policies with regard to irrigation interval.

	Policy A	Policy C
Differential irrigation treatment, per irrigation	10.9 idle days	0.2 idle days
Total man-days per ton of sugar, for irrigating	1.03	1.79
Million gallons of water, per ton of sugar	0.52	0.86
Cost of labor per ton of sugar at $2.00 per man-day	$2.06	$3.58
Cost of water per ton of sugar at $12.00 per million gallons	$6.24	$10.32
Total cost of irrigating, dollars per ton of sugar	$8.30	$13.90
Annual crop, tons of sugar	35,000	35,000
Total irrigation cost, per year	$290,500	$486,500
Difference, in favor of Policy A	$196,000	

TILTING OF THE GROUND AT KILAUEA

By

HUGH H. WAESCHE

Tilt has been defined by T. A. Jaggar and R. H. Finch as "a change in angular relation between a portion of the earth's surface and the plumb line." It is measured by some type of horizontal pendulum such as a seismograph or by special instruments of several types known as clinoscopes. At Kilauea the Bosch-Omori seismograph located on the northeast rim of the crater is extremely sensitive to tilt and is the key station for tilt studies. Clinoscopes are located in cellars on the southeast, west, and northeast rims of Halemaumau. Daily readings are made at all of these stations.

Results of the readings are plotted on coordinate paper and values are measured in degrees of arc departure of the ground from horizontal. At the observatory, tilt has been measured for 27 years. Over this period it has been found that tilt at the northeast rim of Kilauea crater considered as the path of the top of a vertical rod describes an annual loop of from 5 to 20 seconds of rotational arc with the loop elongated in a NNE. to SSW. direction, the greater axis usually being about twice the length of the shorter one. In the course of producing the large loop, many smaller loops occur. Both progress clockwise. The series of charts here discussed are those from 1932 to 1940 inclusive. The plotted points are a smoothed curve of seven-day overlapping mean, for each day of the year. In addition is shown one chart illustrating a curve of unsmoothed daily tilt and another graph showing monthly tilt for N. to S. component and E. to W. component independently as well as an average curve plotted with these. One chart, illustrating tilt at a Halemaumau clinoscope, completes the group. Most of the Halemaumau tilt appears to have been roughly to the WNW.

Tilt and seasonal temperature change at Kilauea seem correlated: northeast tilts with colder weather in late winter and spring and southwest tilts with warmer weather in summer and fall. There appears to be no relation between tilt and rainfall. In the past there has been direct relationship between lava movement and amount and direction of tilt at the observatory. The 1932 Halemaumau inflow was preceded by increased northeast tilt and then recession to the southwest. On October 6, 1935 before the Mauna Loa northeast rift eruption, tilt at the observatory began an abnormal southeast movement continuing until the third week in November when the direction changed to northeast and then gradually receded to the northwest where on January 5, 1936 it was at its normal position to start the new annual circuit. Mauna Loa outflow began November 21, 1935 and ended January 2, 1936.

The approximate center of each annual loop migrated southwest between 1936 and 1939 inclusive. Accumulated tilt had however recovered two seconds of arc to the north at the end of 1939 over either the preceding year or 1937. In March 1940 the relative position was the same; this may be significant of volcanic change.

LAGS AND RANGES OF TEMPERATURES IN HAWAII

By

STEPHEN B. JONES

Leighly's study of the lag of seasons (The extremes of the annual temperature march with particular reference to California: Univ. Cal. Pub. Geog. **6**:191-234, 1938) shows that the effect of relatively close proximity to the sea may be nullified if topography or wind prevents ingress of maritime air to the "climatological air" in which measurements are made. The low amplitudes of Hawaiian temperature curves do not permit the use of Leighly's device for determining extremes, but the lags of the midpoints of the 120 warmest and 120 coolest days agree in a general way with his theories, cloudiness and rain being also important. Lags were determined for the 43 Hawaiian stations having temperature records of 20 or more years. Summer lags are equal to or greater than winter lags at all stations. The greatest and least summer lags (of 120-day midpoints) are 84 and 45 days. For winter, the corresponding figures are 62 and 44 days. Except for a few peculiar stations, the greatest lags are found in rainy localities on northeast (windward) coasts. The lags differ by as much as two weeks on windward and leeward coasts of a mountainous island only 600 square miles in area.

The theoretical insolation curve for 20 degrees north latitude shows a broad maximum and sharp minimum. However, most Hawaiian stations, and also the sea and air temperatures of the ocean about the islands, show curves more or less sinusoidal. Two common deviations from the sinusoid are warm Februaries, due probably to low rainfalls frequent in that month in the present century, and cool early summers, due probably to the steadiness of the trade winds then. Summer truncation due to convectional cloud cover is notable at two stations in the lee of high mountains: Kula Sanitorium on Maui, and Kealakekua in the Kona coffee belt on Hawaii. At Kealakekua (10-year record) the lags of the mean daily maxima and minima are three or four months out of phase. The curve of minima has small lags, but the curve of maxima reaches its lowest in April and its highest in November.

Annual range of temperature varies nearly 100 percent in the islands (from 4.4 to 8.5 degrees F.) and more than 50 percent on different coasts of a single small island, lee coasts usually having the larger ranges. Low annual ranges usually are accompanied by low means and low mean maxima and usually are found in windward locations of heavy rainfall. At low altitudes (400 feet and less) on rainy coasts, the lapse rate is almost isothermal.

A difference of 50 percent or more in daily range between coasts of a small island may be noted, lee slopes usually having the greater ranges. Windward stations usually have greater daily ranges in winter than summer, by three degrees or more in some cases, while leeward stations usually have greater ranges in summer than winter. Greater uniformity on all coasts is characteristic of winter, with its more variable winds. Greater contrast is found in the summer months of steady trades.

THE ECOLOGICAL APPROACH AS A BASIS FOR AGRICULTURAL DEVELOPMENT IN HAWAII

By

J. RIPPERTON AND E. Y. HOSAKA

A scheme was proposed of classifying the lands of the Territory into a series of zones, which it is believed will be useful in the further development of diversified agriculture in Hawaii. The division into zones is based on a combination of climatic factors and the natural or wild vegetation. Division into zones on the basis of existing climatic data is not satisfactory because of the lack of adequate rainfall data in many areas and the lack of information as to differences in solar radiation, wind velocity, relative humidity, etc. Full use of wild vegetation is hampered by the destruction or changing of the native flora and by the introduction of many exotic species so that it is often a matter of speculation as to what the plant association has been in any particular area or what the future one will be. A combination of the two approaches furnishes, it is believed, a fairly satisfactory division as a tentative basis until more exact information is available.

These zones have been set up primarily as a basis for classification of ranges and pastures. As a result of rather extensive field survey, a total of about 350 species existing on the range have been listed and set up in a table showing their distribution by zones and by islands, and their general habits of growth and forage value.

LAND UTILIZATION IN THE TERRITORY OF HAWAII, 1940

By

JOHN W. COULTER

In 1933 I published a research bulletin under the title, "Land Utilization in the Hawaiian Islands" (University of Hawaii Research Publication, no. 8). A demand has arisen for a second edition of the bulletin, which will be published by the Agricultural Extension Service of the University probably under the title, "Agricultural land use planning in the Territory of Hawaii." The same maps and graphs will be used as they appeared in the first edition, for there has been no change in land utilization since 1930 sufficently important to make changes on small maps. Factors of weather and climate which affect small farming and diversified agriculture in general have become more fully understood since the first bulletin was published.

Setting up a technology for farming in the tropics is difficult for people accustomed to farming in the temperate zone. Important phases of scientifically directed agriculture for the Territory lie in the field of the social sciences. An agricultural program will go hand in hand with Americanization. An important phase of the problem is that of land ownership and farm security.

The sugar industry in the islands had an experimental period of 50 years. The experimental period for the pineapple industry was shorter, for scientific resources and capital were more adequate at the time this enterprise was started. When other proper adjustments to the environment of the Territory appear they can be developed more quickly with the employment of government or private capital than did the two major crops, for we now have accessible more scientific and business knowledge.

CONTROL OF DORMANCY IN SEED POTATOES

By

H. DAVID MICHENER

Seed potatoes have a natural dormant period lasting 2 or 3 months after harvesting. This fact is of considerable importance in Hawaii, as seed is harvested in September on the mainland and is still dormant when it reaches Hawaii for fall plantings. Some method for shortening this dormant period is desirable.

Ethylene-chlorohydrin vapor (at the rate of about 0.65 gram chlorohydrin per kilogram of potato tubers) has given the best result of any treatment used so far. It causes germination of the tubers within a short time (usually 15 or

20 days) after treatment. It also causes all the seed to germinate at once, whereas individual tubers from untreated seed may differ by several weeks in their time of germination, and some of the plants are ready to harvest while others have not yet had time to form mature potatoes. This results in considerable loss in yield.

The ethylene-chlorohydrin treatment increases the yield even from seed that is beginning to germinate at the time of treatment. In an experiment with such seed, the untreated lot came up slightly later and died slightly later than the treated seed, but both groups had about the same growing period. The treated seed gave a significantly greater yield, the result of an increase in the number of tubers formed rather than of an increase in tuber size. The best treatment produced a 21 percent increase in total yield, but it is probable that larger increases can be obtained with improved methods of treatment.

The average number of stems per hill was increased by the ethylene-chlorohydrin treatment. It has been shown by other workers that an increase in the number of stems (when there are less than four stems) produces an increase in yield.

DECREASE OF HAWAIIAN PASSERINE BIRDS

By

GEORGE C. MUNRO

In the late eighties and early nineties there was fairly complete investigation of the Hawaiian avifauna. This showed that five species on Oahu, two on Hawaii, and one on Lanai were nearly or quite extinct. Decrease after that continued intermittently. A survey made in 1935-37 seemed to show that 21 species would possibly survive and that 31 species were doomed to extinction, and some of them already irrevocably gone. The fact that the Hawaii National Park Service in recent years has instituted research into the causes of the decrease of the Hawaiian passerine or perching birds gives hope that something may be accomplished in saving some of these birds that seemed hopelessly doomed to extinction a few years ago.

In the writer's opinion the evidence is conclusive that introduced bird diseases are mainly responsible for the reduction in numbers in some and the complete extinction of other species of the native perching birds, which are susceptible to these diseases. Investigation alone can show whether this is true and perhaps point some way to combat it. The genus *Chasiempis,* a flycatcher, the *elepaio* of the Hawaiians, is the only genus that seems immune and the three species are still thriving even at the lower levels where all the other native birds have disappeared.

Already steps are being taken at the Hawaii National Park to prevent infection being carried from poultry yards into the forest. It seems advisable to do this at human settlements at other high levels on other islands. In the high and isolated forests of several islands there are representatives of some of the interesting Hawaiian forms still existing in fair numbers where they are remote from human habitation. If they are made safe from infection they will likely spread back to places where they were numerous in the nineties and again furnish spectacular scenes such as those described by R. C. L. Perkins and other writers who saw them before they were reduced in numbers.

(This report was published in full in the Honolulu Star-Bulletin, June 8, 1940.)

THE OCCURRENCE OF GROUND WATER IN THE HAWAIIAN ISLANDS

By

HAROLD T. STEARNS

Ground water in Hawaii occurs chiefly in three ways—basal, perched, and confined. Basal water occurs as follows: (1) shallow water in the limestone, volcanics, gravel, and other permeable rocks that form the coastal plains, usually without restraining beds; and (2) water in the basalts, with or without restraining beds. It is artesian if restrained by buried soils or clays of the coastal plains. Basal water generally floats on salt water according to the Ghyben-Herzberg principle and is usually recovered by means of Maui-type wells (shaft and infiltration tunnel) or drilled wells.

Six types of structures perch water or hold it above the basal water table in a basaltic island. They are (1) sills, (2) ash or tuff beds, (3) soil, (4) alluvium, (5) ice, and (6) dense flow rock. Ash and alluvium perch the most water. It is generally recovered by tunnels contouring the surface of the perching formation.

Confined water occurs in compartments of porous lava between dikes. Such water extends to considerable depth below sea level in most places and is usually resting on impermeable intrusive rock and not floating on sea water. It is obtained by means of horizontal tunnels driven at right angles to the trend of the dikes, or by the Lanai-type well (shaft and infiltration tunnel in the dike complex). Saturated dike complexes capped by impermeable alluvium may yield small quantities of artesian water.

NECROLOGY

Dr. Royal Norton Chapman, educator and scientist, died on December 2, 1939, in Minneapolis. He was born in Morristown, Minnesota, on September 17, 1889. He received college degrees from the University of Minnesota (B.A., 1914; M.A., 1915) and Cornell University (Ph.D., 1917). As teacher and professor at Minnesota, Dr. Chapman developed a new method of experimental animal ecology, 1917-1930. In 1930 he came to Hawaii to become director of the Pineapple Experiment Station. In addition to helping to solve pineapple problems, he made splendid contributions to the development at the University of Hawaii of a Graduate School of Tropical Agriculture, to the Institute of Pacific Relations, the Y.M.C.A., and many other civic and scientific activities. In the summer of 1939 he returned to the University of Minnesota to become dean of the Graduate School. His was a life filled with many and diverse accomplishments. How regrettable that it should have been cut off upon the threshold of a new and chosen field.

Albert Francis Judd, president of the board of trustees of Bernice P. Bishop Museum, died December 18, 1939. He was born in Honolulu December 20, 1874, the eldest son of a distinguished adviser of Hawaiian royalty. He was educated at Oahu College and Yale University, B.A. 1897, and LL.B. 1900. He practiced law in Honolulu from 1899 to 1914 and occupied many public positions including that of senator to the Hawaiian Legislature, 1911 and 1913. In 1908 he became a trustee of the Bernice P. Bishop Estate and of the Bishop Museum, and devoted much of his time and energy to the welfare of the Kamehameha Schools and the work of the Museum. Several expeditions to Samoa gave him keen insight into the ethnology and natural history of that group. He was a logical choice as chairman of the committee of the Frederic Duclos Barstow Foundation, which established the Felete School on Tutuila, to help improve the educational adjustments of Samoans. A man of vision and tireless energy to accomplish what he thought was right, Mr. Judd made valuable contributions in many fields; and by kindly advice and sterling example helped many associates to valuable accomplishments.

William R. McAllep, consulting sugar technologist with the Experiment Station of the Hawaiian Sugar Planters' Association, died in Honolulu, October 21, 1939. He was born in San Francisco, September 28, 1880, and was a graduate of the University of Southern California. After working with several of the beet sugar factories of the west, he came to Hawaii in 1915 as assistant sugar technologist with the Hawaiian Sugar Planters' Association. He was appointed to head the department in 1920, and became consulting technologist

in 1934. He was a member of the University of Hawaii faculty, as lecturer on sugar technology, beginning in 1919. He served as vice president and president of both the Hawaiian Chemists' Association and the Association of Hawaiian Sugar Technologists, and was a member of several American and foreign chemical societies.

Harold Francis Willard, entomologist, died in Honolulu, August 18, 1939. He was born in Neillsville, Wisconsin, February 21, 1884. After graduating from Massachusetts Agricultural College in 1911, he came to Honolulu and taught agriculture in Mills School, Mid-Pacific Institute, for about three years. He then became a homesteader at Haiku, Maui. In 1916 he began a study of fruit flies in Hawaii for the U. S. Bureau of Entomology, working with E. A. Back and C. E. Pemberton. He made valuable contributions to the knowledge of the interrelation of parasites of the fruit flies. He also worked on the parasites of the pink boll worm in Hawaii. From 1929 until the time of his death he had charge of the Hawaii field office of the United States Bureau of Entomology and Plant Quarantine. In his work as a regulatory official in the enforcement of provisions seeking to prevent the spread of insect pests to the mainland United States, he had the confidence of growers, shippers, and transportation officials. He took a large part in fraternal, religious, and civic activities.

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